Biogeochemical Implications of Dissolved Trace Metal Concentration and Distribution in the South China Sea, Area 1: Gulf of Thailand and East Coast of Peninsular Malaysia

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ABSTRACT

Dissolved cadmium, copper, iron, lead and nickel in seawater at different depths were analyzed using the cobalt-APDC coprecipitation technique. The concentrations found were low and within the range found in natural seawater elsewhere. Terrestrial sources, especially near the head of the Gulf of Thailand and the Nakorn Sri Thammarat-Songkhla area on the Thai-Malay Peninsular, were clearly observed especially during the high runoff season. External input and horizontal dispersion dominated over internal recycling and removal in controlling concentration and distribution of iron and copper but it was the opposite for cadmium, nickle and lead where biological removal near surface and bottom regeneration might explain the "nutrient type" vertical profiles of these elements.

Introduction

Trace metals are the natural components in seawater. Prior to the period of human disturbance of the environment, trace metals in the water were derived from continental rocks by weathering and partly from sediment due to leaching, desorption, dissolution, cation exchange, and other processes. For some elements, such as lead, anthropogenic atmospheric input may also be important. As the natural system is at equilibrium, the input must be equal to the output where these dissolved trace metals in the water are removed back to solid phase, i.e. sediments, by a suite of geochemical reactions such as adsorption, precipitation and cation exchange. Some metals, mercury for example, can be volatile and removed via the atmosphere. These physical and chemical processes involving trace metals are strongly controlled by environmental factors, for instances, temperature, salinity (ionic strength), pH and redox potential (e.g. Drever, 1989).

It was suspected that trace metals at some locations in the Gulf of Thailand and Eastern Peninsular Malaysia may be originated from anthropogenic sources. However, due to difficulties in analyzing very low concentration of trace elements in seawater which has a very high ionic strength, most of previous measurement before 1980 were probably unreliable. Utoomprurkporn et al. (1987) had shown that trace metal concentrations reported for several estuarine and coastal water in the Gulf of Thailand were gradually decreasing by as much as 500 times from 1979 to 1985. It is highly unlikely that this was due to a drastic reduction in metal loading. Actually anthropogenic loading is known to increase. Improvement in sampling and analytical techniques are more reasonable explanations.

Concentration and distribution of trace metal in large coastal area, such as the Gulf of Thailand and Eastern Peninsular Malaysia, can provide some details on sources, cycling and removal processes. It is also a good indicator for human impact and imprint on the environment and quality of its living resources.

Methods

Sampling

Seawater from at least two depths (surface and bottom) were collected from pre-selected stations using 2.5 liter Teflon coated General Oceanic GoFlo samplers attached to a rosette. There were a total of 19 and 80 stations for September 1995 and April-May 1996 cruises, respectively. At some stations, water at intermediate depths were also collected to get a resolution for the vertical profiles of trace metals.

Once water samples were on board they were immediately transferred into 1 liter Nalgene polyethylene bottles. Within an hour after sampling, seawater was filtered on board using filtered compressed air and an in-line filtration apparatus. Nuclepore 0.4 mm membranes were used. Filtered water was acidified to pH ∪ 3 with Suprapure HNO_3 acid

Sample preparation and analysis

Dissolved trace metals in water samples were coprecipitated with cobalt-APDC (Boyle and Edmond, 1977, modified by Huizenga, 1981). Precipitates were collected by hand vacuum filtration on Nuclepore 0.45 mm membranes. The precipitates were further taken up in HNO_3 and diluted with Milli-Q water. The final solutions were measured for cadmium, copper, iron, lead and nickel using a Perkin Elmer Zeeman Graphite Furnace 4100ZL atomic absorption spectrophotometer. Merck standard solutions diluted by Milli-Q water was used as standards. Certified Reference Seawaters NASS-1 and CASS-2 of the Institute for Environmental Chemistry, Canada, were included in every batch of sample preparation and analysis as quality control samples to ensure the accuracy of the results (Table 1).

All bottles, filter membranes and labwares that would be in contact with samples were carefully pre-washed by 10% Suprapure HNO_3 acid and Milli-Q water.

Table 1. Analytical performance based on two Reference Seawater (Mean ± SD, μg/l)

	Cd	Cu	Fe	Pb	Ni
NASS-1	0.029±0.004	0.099±0.010		0.039±0.006	0.257±0.027
Our results	0.031±0.002	0.102±0.018		0.034±0.007	0.265±0.016
CASS-2	0.019±0.004	0.675±0.039	1.20±0.12	0.019±0.006	0.298±0.036
Our results	0.024±0.004	0.638±0.036	1.26±.13	0.021±0.002	0.283±0.039

Results and Discussion

The results clearly show that concentration of the five dissolved trace metals in every samples were very low and well within the range found in normal nearshore seawater elsewhere. These metals may be divided into two categories according to their vertical distribution, (a) those without bottom enrichment, and (b) those with strong bottom enrichment (Table 2, 3).

Trace metals without bottom enrichment

Iron and copper fell into this category. Terrestrial runoff via the Upper Gulf and from Nakorn Sri Thammarat-Songkhla area clearly cause extensive surface plumes during the periods of both cruises (Figs. 1 and 2). Concentration of the two metals in the surface plumes, especially at stations near to the discharge locations during the high runoff (September 1995), were generally higher than the concentrations in bottom water. Dissolved metals found in the plume could be both in truly ionized forms and those chelated with dissolved organic matters. The latter form could be especially

Table 2 Concentrations of trace metals in the Gulf of Thailand and East Coast of Peninsular Malaysia

Metal	Sept. 95	April-May 96
Cd (ng/l) surf	1.0-4.8	0.1-11.1
bot.	2.1-7.8	3.3-18.5
Pb (µg/l) surf.	0.01-0.15	0.01-0.18
bot.	0.01-0.44	0.01-0.19
Ni (µg/l) surf.	0.1-0.5	0.1-0.5
bot.	0.1-1.0	0.1-0.7
Cu (µg/l) surf.	0.1-0.9	0.1-0.6
bot.	0.1-1.3	0.1-0.5
Fe (µg/l) surf.	0.5-4.9	0.4-3.0
bot.	0.6-4.5	0.3-3.0

Table 3. Generalization of vertical distribution pattern of 5 metals at coastal plumes and offshore water of the Gulf during the high and low river discharge seasons.

Element	Sept. 95 (High Runoff)		April-May 96 (Low Runoff)	
	Plumes	Offshore	Plumes	Offshore
Ni	BE	VH, BE	SE	VH
Cd	BE	VH, BE	VH	BE
Pb	BE	BE	VH	VH
Cu	VH, SE	VH, SE	SE	VH, SE
Fe	VH, SE	VH	VH, SE	VH

BE: Bottom enrichment
SE: Surface enrichment
VH: Vertically homogeneous

important for copper.

Concentration and vertical distribution of trace metals in this category could be chiefly determined by river input and horizontal dispersion. Biological uptake by phytoplankton, regeneration by organic decay in deep water layer and those released from sediments were apparently insignificant relative to the horizontal input since there was not a clear vertical gradient observed.

Trace metals with strong bottom enrichment

This category includes cadmium and lead. River input, which even though was the largest external source, left only small recognizable impact and only very near to river mouths in the high runoff season (Figs. 3 and 4). This indicated internal processes that were fast and efficient relative to runoff in controlling the metal concentration. The “nutrient type” behavior of these metals, i.e. low

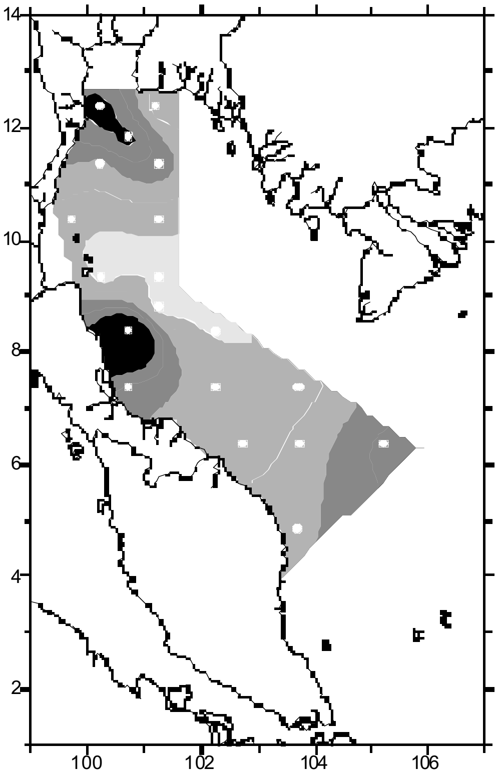

Fig. 1a. Concentration of iron (μg/l) in surface water in September 1995

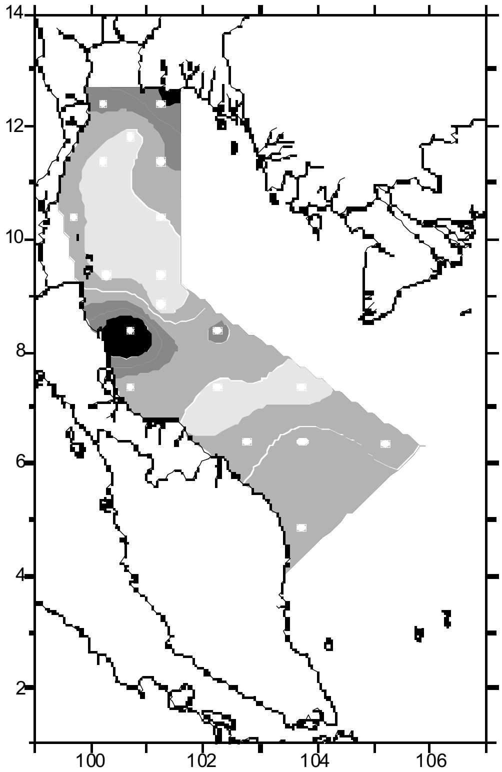

Fig. 1b. Concentration of iron (μg/l) in bottom water in September 1995

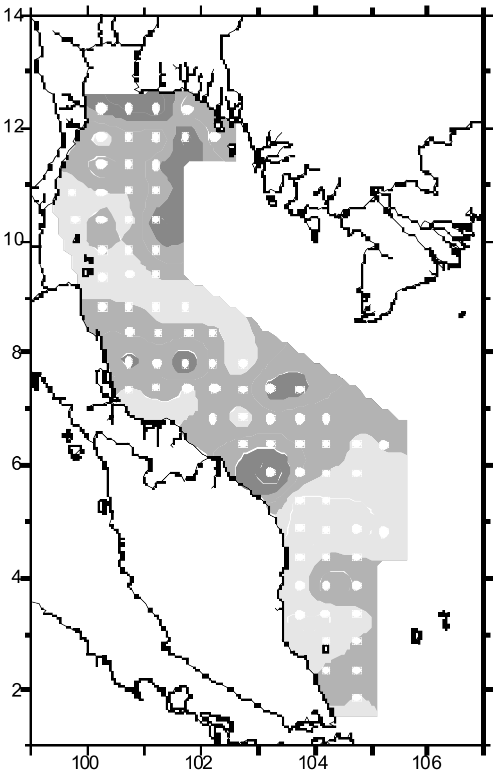

Fig. 1c. Concentration of iron (μg/l) in surface water in April-May 1996

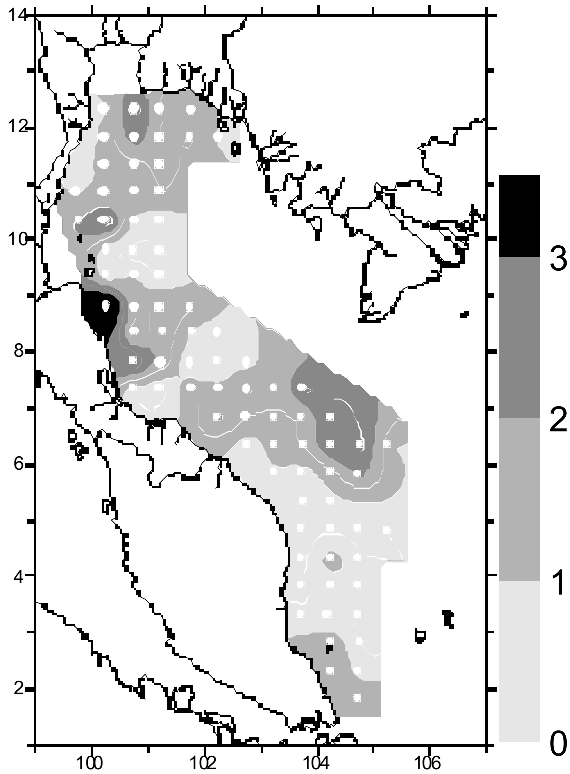

Fig. 1d. Concentration of iron (μg/l) in bottom water in April-May 1996

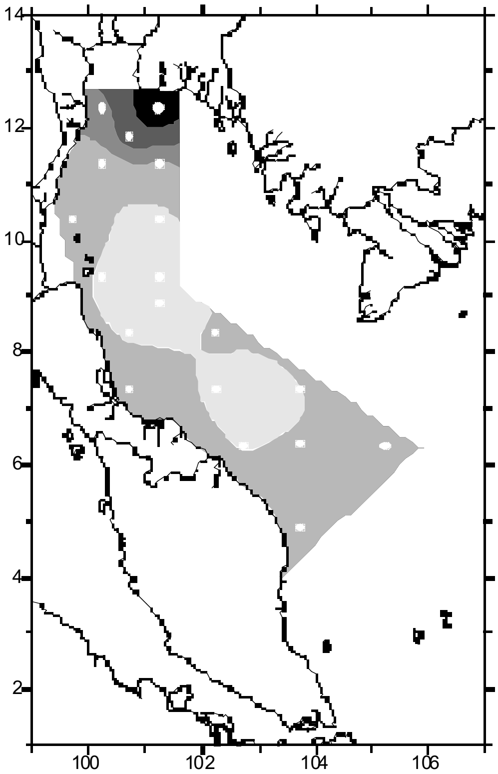

Fig. 2a. Concentration of copper (μg/l) in surface water in September 1995

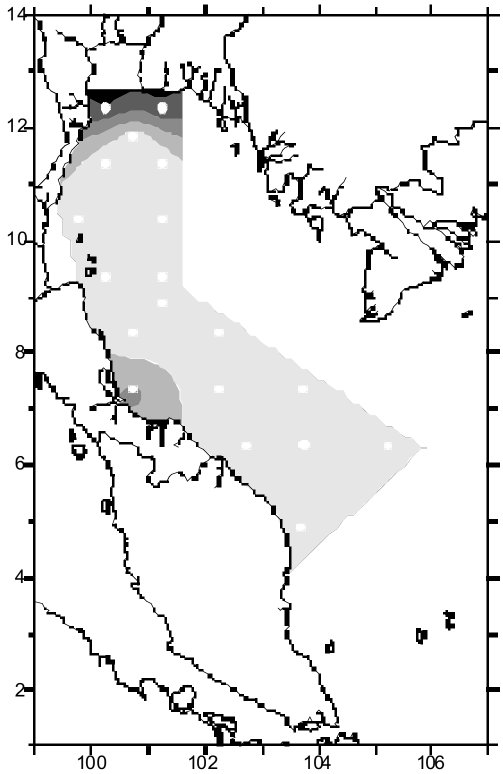

Fig. 2b. Concentration of copper (μg/l) in bottom water in September 1995

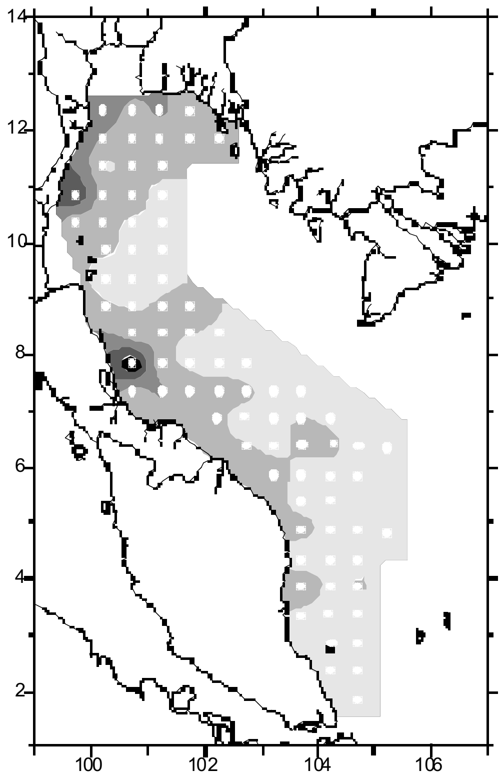

Fig. 2c. Concentration of copper (μg/l) in surface water in April-May 1996

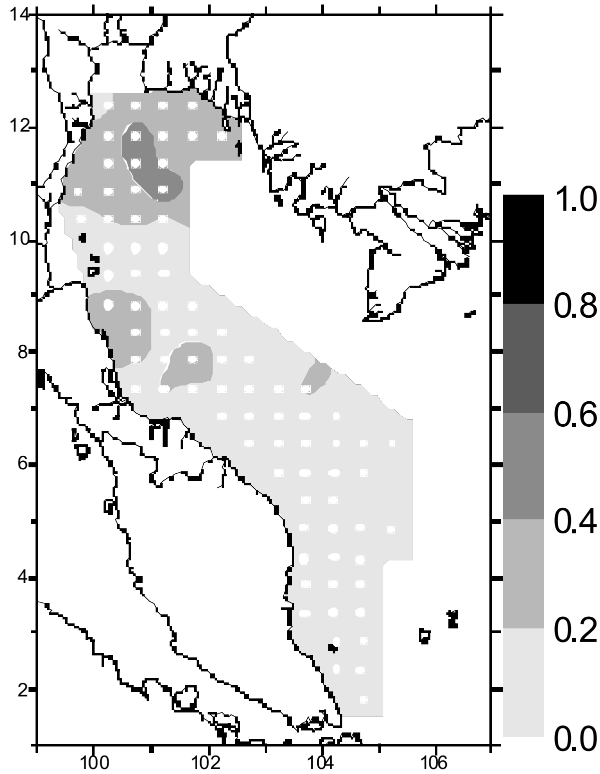

Fig. 2d. Concentration of copper (μg/l) in bottom water in April-May 1996

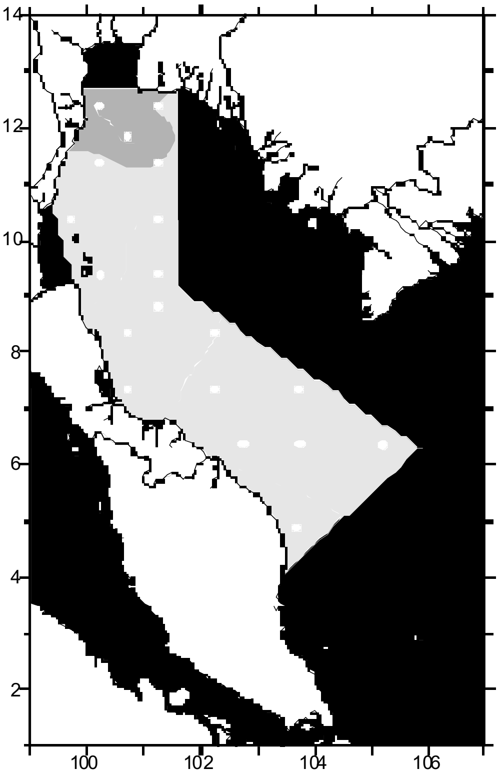

Fig. 3a. Concentration of cadmium (ng/l) in surface water in September 1995

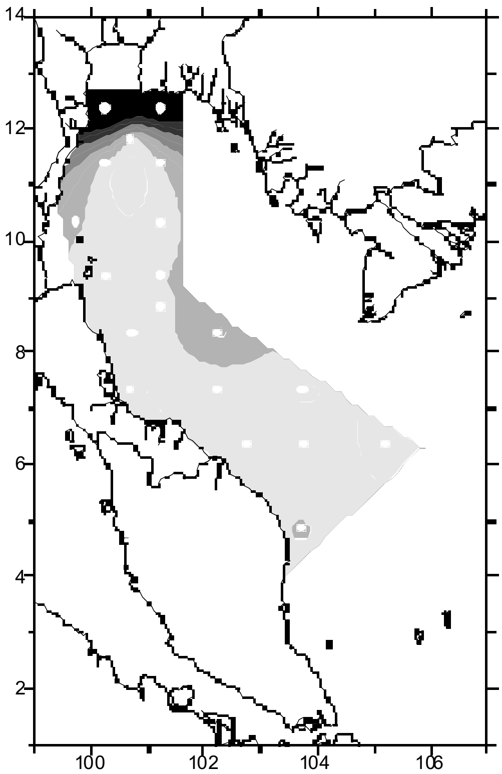

Fig. 3b. Concentration of cadmium (ng/l) in bottom water in September 1995

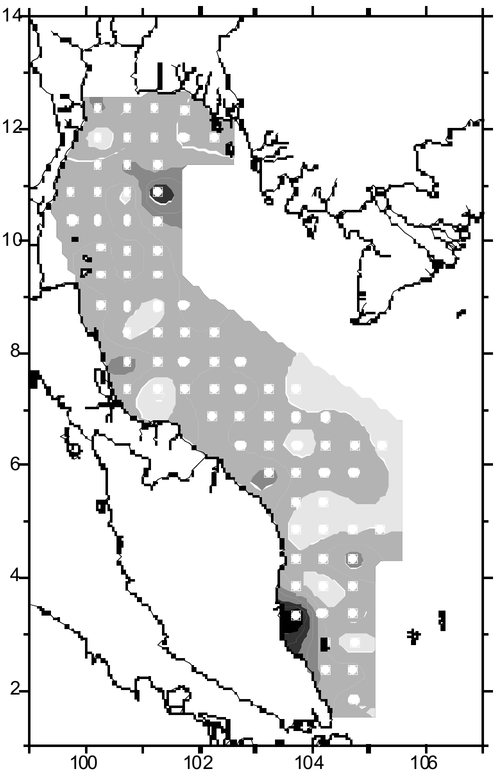

Fig. 3c. Concentration of cadmium (ng/l) in surface water in April-May 1996

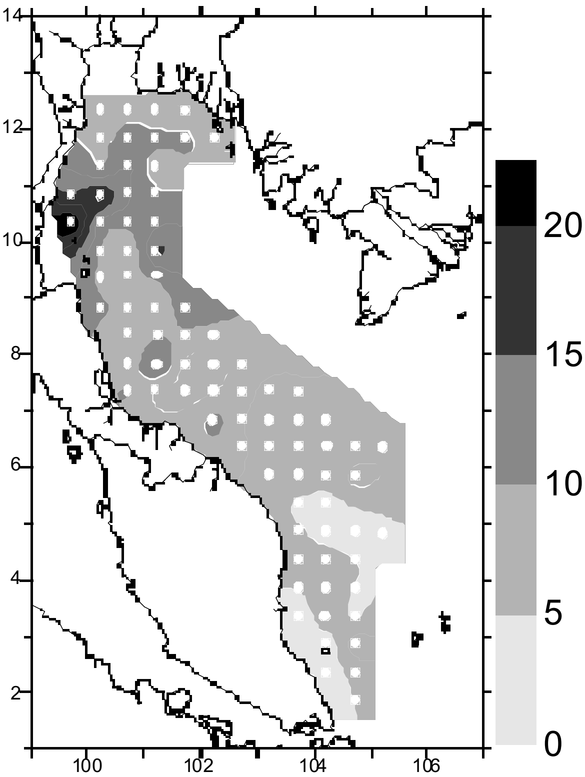

Fig. 3d. Concentration of cadmium (ng/l) in bottom water in April-May 1996

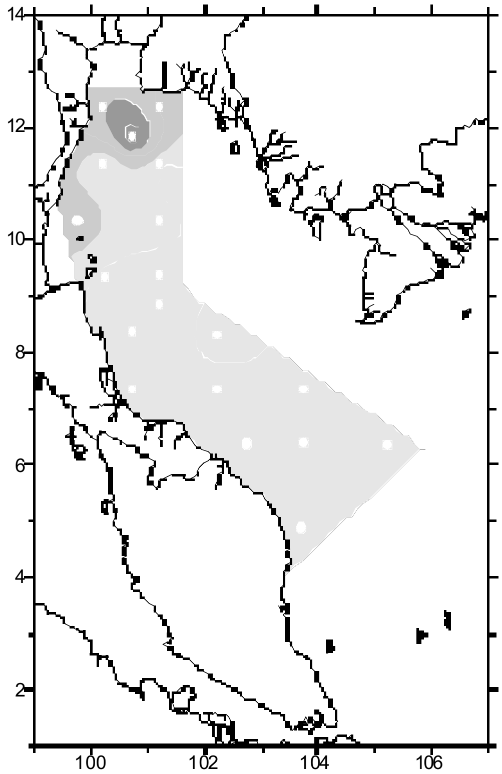

Fig. 4a. Concentration of lead (μg/l) in surface water in September 1995

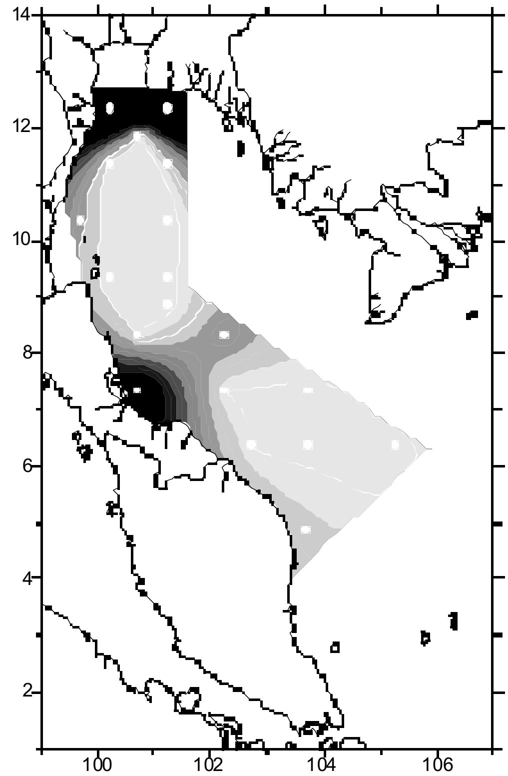

Fig. 4b. Concentration of lead (μg/l) in bottom water in September 1995

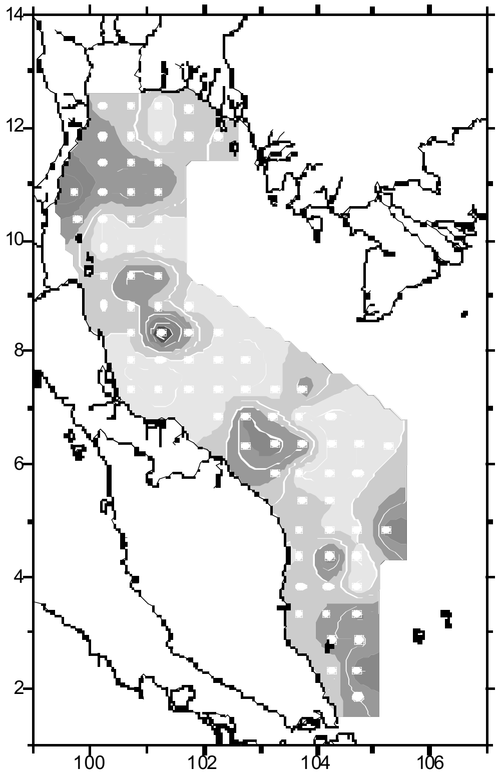

Fig. 4c. Concentration of lead (μg/l) in surface water in April-May 1996

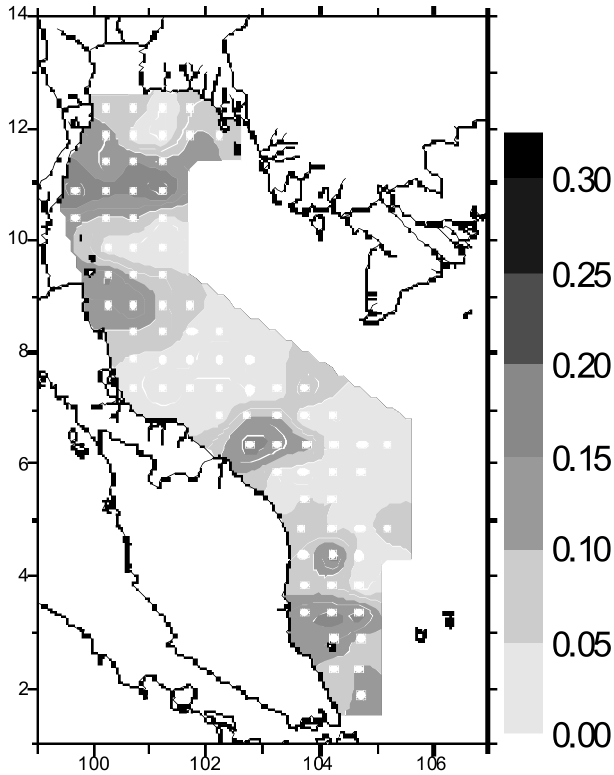

Fig. 4d. Concentration of lead (μg/l) in bottom water in April-May 1996

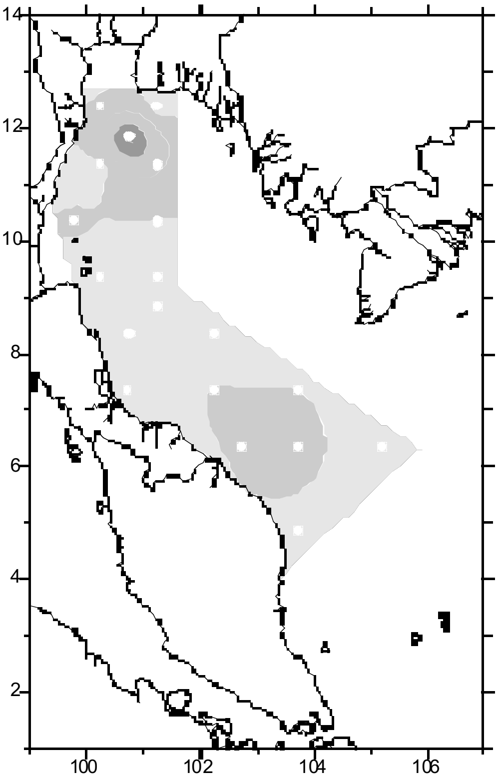

Fig. 5a. Concentration of nickel (μg/l) in surface water in September 1995

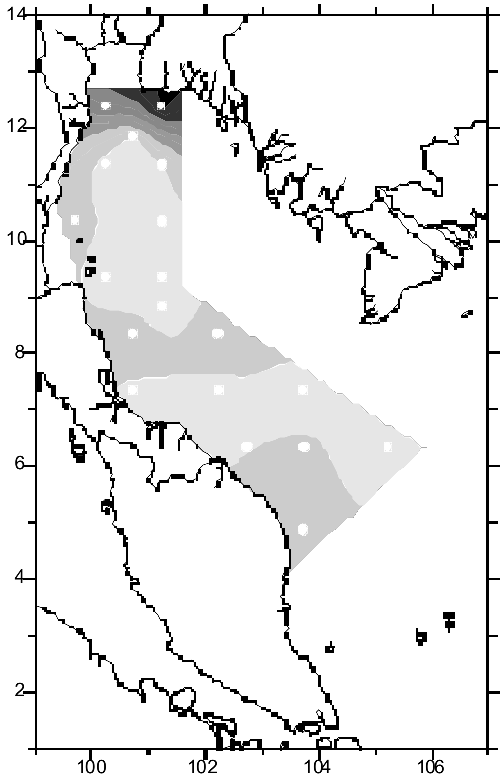

Fig. 5b. Concentration of nickel (μg/l) in bottom water in September 1995

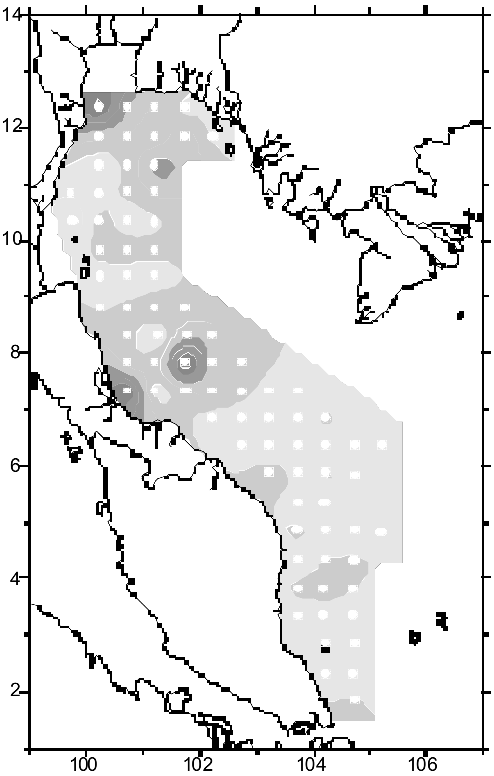

Fig. 5c. Concentration of nickel (μg/l) in surface water in April-May 1996

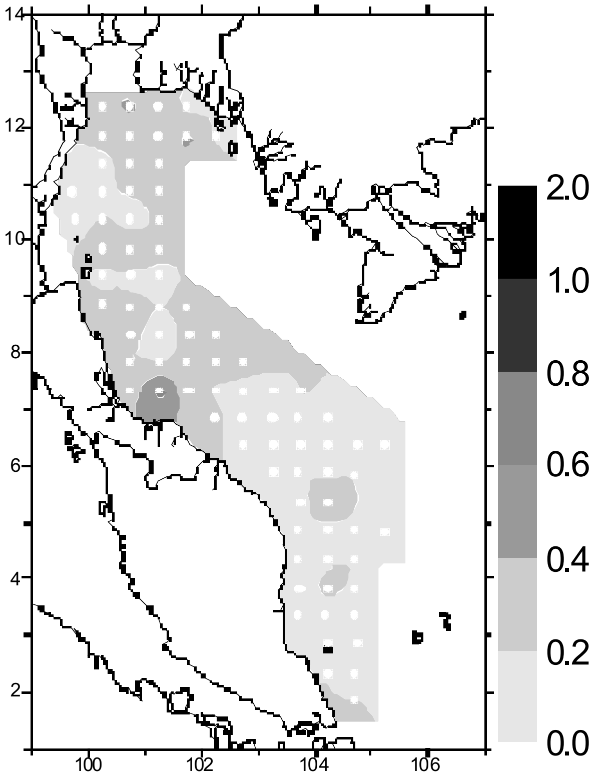

Fig. 5d. Concentration of nickel (μg/l) in bottom water in April-May 1996

concentration at sea surface and enriched near bottom, obviously pointed out that biological processes played some roles in their internal cyclings. Biological uptake especially by phytoplankton in the surface layer could deplete the concentration quite fast, relative to the lateral transport. Settling of organic particles and subsequent decays in bottom layer enriched bottom water by regenerated metals. In addition, sediments could be another significant source of these metals for bottom water of this study area.

Nickel might have been included in this category (b), even though it had a mixed behaviors between the two groups. During the high runoff, it behaved like cadmium and lead while behaved like iron and copper during the dry season. The Upper Gulf and Songkhla lagoon were external source for nickel, especially in April-May 1996 (Fig. 5).

Summary

1) The concentrations of all five trace metals found in this study were not unusually high.
2) The plume from the Upper Gulf was the largest source of all five trace metals for the Gulf of Thailand. The second source appeared to be the land area of Nakorn Sri Thammarat and Songkhla Provinces.
3) These five metals could be subdivided into two groups based on their vertical distribution. Iron and copper, which had no significant bottom enrichment, could be controlled by external sources and horizontal dispersion while cadmium, nickle and lead showed some degree of bottom enrichment, indicating roles of biological processes and sediment fluxes.

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Appendix A. Dissolved trace metals in seawater in September 1995. Concentrations in parentheses are excluded from discussion

Stations	Depth (m)	Pb (µg/l)	Cd (ng/l)	Cu (µg/l)	Ni (µg/l)	Fe (µg/l)
1	0	0.099	7.75	0.53	0.22	3.26
	24	(0.792)	(31.58)	(8.69)	0.68	2.20
3	0	0.066	4.79	0.95	0.17	0.98
	28	(0.758)	(25.68)	(6.72)	1.01	2.99
8	0	0.148	8.19	0.73	0.55	3.23
	5	0.061	5.78	0.40	0.22	0.94
	10	0.147	5.67	0.32	0.29	1.81
	20	0.395	6.05	2.24	0.46	2.80
	30	0.020	2.46	0.40	0.18	0.85
	35	0.020	3.25	0.97	0.17	0.54
10	0	0.021	3.75	0.23	0.17	1.79
	45	0.017	3.39	0.13	0.15	0.78
12	0	0.023	4.83	0.34	0.32	2.40
	55	0.076	4.89	0.27	0.20	2.01
17	0	0.076	2.93	0.29	0.22	1.17
	40	0.106	5.63	0.43	0.27	1.10
20	0	0.029	2.13	0.16	0.19	1.13
	60	0.008	3.90	0.09	0.14	0.92
24	0	0.016	3.13	0.18	0.15	0.75
	26	0.017	2.71	0.12	0.14	0.86
26	0	0.020	2.00	0.16	0.15	0.97
	60	0.020	4.89	0.12	0.13	0.78
28	0	0.012	0.98	0.12	0.13	0.50
	55	0.012	4.13	0.07	0.11	0.38
31	0	0.015	1.28	0.17	0.16	4.90
	26	0.034	4.22	1.32	0.28	4.54
34	0	0.035	2.50	0.22	0.15	0.91
	10	0.045	1.61	0.31	0.20	1.34
	20	0.02	2.09	0.23	0.14	1.25
	30	0.029	4.40	0.36	0.17	1.20
	40	0.020	4.61	0.27	0.19	0.87
	50	0.020	6.39	0.20	0.19	1.04
	60	0.086	13.27	0.62	0.30	2.97
	70	0.02	3.73	0.25	0.19	1.66
	74	0.149	7.77	1.05	0.28	2.27
40	0	0.017	2.09	0.38	0.16	2.23
	19	0.437	2.21	0.47	0.18	1.16
43	0	0.017	3.25	0.16	0.21	1.64
	48	0.022	3.09	0.11	0.17	0.72
46	0	0.017	4.71	0.20	0.20	1.29
	48	0.012	2.14	0.15	0.15	0.64
52	0	0.017	2.73	0.19	0.20	1.22
	36	0.024	3.01	0.13	0.20	1.26
54	0	0.021	3.13	0.22	0.22	1.69
	57	0.018	4.72	0.20	0.22	1.96
57	0	0.016	28.13	0.23	0.15	2.72
	58	0.013	1.32	0.22	0.14	1.36
64	0	0.025	2.02	0.39	0.19	1.87
	56	0.065	5.20	0.58	0.25	1.92

Appendix B. Dissolved trace metals in seawater in April-May 1996. Concentrations in parentheses are excluded from discussion.

Stations	Depth (m)	Pb (μg/l)	Cd (ng/l)	Cu (μg/l)	Ni (μg/l)	Fe (μg/l)
1	0	0.089	10.58	0.558	0.737	2.30
	27	0.075	8.02	0.188	0.359	0.90
2	0	0.095	7.16	0.318	0.394	2.66
	5	0.105	12.59	0.437	0.511	2.81
	10	0.184	8.65	0.406	0.355	4.79
	15	0.105	8.03	0.393	0.419	6.42
	20	0.076	6.39	0.161	0.285	1.10
	27	0.083	9.67	0.344	0.429	2.88
3	0	0.025	8.65	0.469	0.289	2.95
	5	0.029	7.82	0.330	0.273	1.98
	10	0.017	9.19	0.233	0.187	0.95
	15	0.032	13.53	0.564	0.455	1.70
	20	0.016	8.06	0.225	0.170	0.78
	31	0.019	7.89	0.203	0.246	1.31
4	0	0.089	7.41	0.215	0.177	1.09
	15	0.083	9.94	0.197	0.146	0.78
	18	0.094	8.51	0.240	0.196	1.24
	20	0.073	6.94	0.215	0.160	0.88
	24	0.076	6.89	0.172	0.149	0.64
	26	0.078	7.38	0.222	0.181	1.15
5	0	0.070	6.64	0.238	0.162	1.06
	10	0.109	8.52	1.057	0.180	1.20
	20	0.100	9.32	0.348	0.209	0.80
	26	0.108	6.87	0.188	0.168	0.77
	29	0.090	6.94	0.217	0.165	0.90
6	0	0.081	6.79	0.326	0.390	2.88
	10	0.083	7.28	0.212	0.368	1.60
	20	0.079	7.15	0.189	0.338	3.01
	25	0.099	9.23	0.157	0.328	2.85
	30	0.091	5.99	0.154	0.306	2.25
	40	0.090	6.76	0.167	0.482	1.17
	50	0.112	11.36	0.202	0.434	1.57
7	0	0.027	8.89	0.180	0.213	0.71
	45	0.015	10.85	0.264	0.270	1.33
8	37	0.028	10.97	0.544	0.249	2.33
9	0	0.117	1.57	0.356	0.304	0.59
	20	0.397		1.357	0.307	1.83
	35	0.127		0.258	0.265	1.13
10	0	0.116	9.96	0.166	0.115	2.10
	47	0.109	9.58	(7.597)	0.132	1.17
11	0	0.118	11.13	0.258	0.237	1.16
	53	0.173	12.95	0.428	0.322	1.30
12	0	0.106	8.72	0.259	0.460	2.09
	25	0.158	7.48	0.243	0.374	1.55
	57	0.134	7.45	0.389	0.407	1.61
13	0	0.125	19.34	0.116	0.326	1.66
	40	0.155	11.70	0.390	0.332	1.39
	65	0.192		0.516	0.286	1.52
14	0	0.140	3.18	0.292	0.229	1.01
	45	0.153	9.91	0.374	0.285	1.47
15	0	0.136	8.14	0.296	0.183	0.89
	53	0.157	18.54	0.284	0.177	1.16
16	0	0.194	8.77	0.834	0.104	0.61
	48	0.191	15.07	0.288	0.109	0.95

Appendix B. continue

Stations	Depth (m)	Pb (μg/l)	Cd (ng/l)	Cu (μg/l)	Ni (μg/l)	Fe (μg/l)
17	0	0.135	8.00	0.212	0.031	0.85
	10	0.163	9.39	0.232	0.141	1.01
	20	0.114	8.57	0.198	0.157	0.79
	30	0.088	7.20	0.150	0.116	0.81
	38	0.076	7.10	0.114	0.121	0.49
	45	0.105	23.15	0.106	0.108	2.06
18	0	0.013	9.75	0.233	0.247	1.27
	60	0.081	10.74	0.202	0.223	3.01
19	0	0.071	5.87	0.172	0.108	0.79
	62	0.099	10.41	0.227	0.109	0.85
20	0	0.034	8.34	0.201	0.183	2.65
	64	0.013	12.33	0.150	0.228	0.70
21	0	0.020	6.66	0.156	0.257	1.90
	68	0.004	15.83	0.157	0.242	0.53
22	0	0.039	8.94	0.193	0.273	0.97
	56	0.016	7.59	0.134	0.379	0.37
23	0	0.022	6.49	0.220	0.262	1.07
	35	0.027	9.22	0.116	0.349	0.64
24	0	0.082	6.86	0.137	0.128	0.51
	10	0.102	6.67	0.120	0.104	0.54
	20	0.083	8.17	0.135	0.029	0.62
	28	0.162	9.15	0.134	0.129	0.70
25	0	0.150	7.72	0.131	0.122	0.48
	40	0.091	9.46	0.150	0.153	1.06
26	0	0.133	7.18	0.149	0.123	1.04
	10	0.148	5.91	0.158	0.161	0.67
	20	0.068	2.85	0.131	0.151	0.49
	30	0.130	5.35	0.122	0.138	0.60
	40	0.074	3.20	0.142	0.152	0.30
	50	0.123	3.90	0.106	0.138	0.56
	63	0.077	9.92	0.126	0.146	0.32
27	0	0.034	8.31	0.277	0.238	0.44
	55	0.041	11.46	0.147	0.189	0.51
	77	0.061	12.26	0.144	0.257	1.58
28	0	0.069	3.76	0.240	0.316	0.83
	58	0.078	7.10	0.173	0.202	1.86
29	0	0.095	5.86	0.199	0.231	1.10
	30	0.153	9.39	0.231	0.275	1.34
30	0	0.088	8.24	0.228	0.192	1.21
	24	0.115	10.48	0.271	0.340	4.94
31	0	0.054	3.91	0.257	0.231	1.45
	27	0.094	7.70	0.289	0.253	1.00
32	0	0.276	5.99	0.229	0.106	1.18
	40	0.100	4.89	0.112	0.082	0.40
	52	0.083	10.01	0.119	0.105	1.84
33	0	0.107	7.12	0.196	0.372	1.38
	45	0.022	6.41	0.173	0.244	2.42
	71	0.034	9.18	0.144	0.268	0.89
35	0	0.012	6.81	0.159	0.264	0.58
	50	0.024	7.08	0.154	0.268	0.70
	70	0.031	9.26	0.168	0.261	0.77
36	0	0.029	7.33	0.165	0.255	1.17
	65	0.036	7.09	0.108	0.225	0.97
	72	0.012	5.50	0.122	0.265	0.56
37	0	0.029	6.37	0.184	0.845	2.71
	40	0.024	7.21	0.161	0.360	0.96
	58	0.026	6.61	0.384	0.230	0.57

Appendix B. continue

Stations	Depth (m)	Pb (µg/l)	Cd (ng/l)	Cu (µg/l)	Ni (µg/l)	Fe (µg/l)
38	0	0.021	7.49	0.227	0.245	1.63
	48	0.026	13.59	0.186	0.211	1.78
39	0	0.025	12.16	1.025	0.252	2.27
	27	0.033	8.24	0.203	0.195	3.16
40	0	0.030	6.92	0.263	0.723	0.83
	10	0.028	8.85	0.183	0.457	0.35
	20	0.029	10.30	0.147	0.295	0.55
41	0		0.61	0.441	0.106	
	40	0.017	6.76	0.210	0.686	0.35
42	0	0.036	7.75	0.243	0.281	0.87
	30	0.042	8.65	0.283	0.473	4.15
	49	0.029	6.09	0.132	0.233	1.41
43	0	0.041	8.82	0.242	0.291	1.20
	35	0.030	8.26	0.173	0.261	2.92
	49	0.036	7.70	0.183	0.188	1.17
44	0	0.027	8.90	0.222	0.221	1.38
	20	0.025	7.18	0.126	0.163	1.20
	52	0.024	8.71	0.113	0.151	2.10
45	0	0.030	6.75	0.154	0.169	2.37
	15	0.037	4.57	0.102	1.006	3.53
	55	0.028	5.97	0.113	0.153	1.63
46	0	0.127	3.57	0.143	0.158	2.15
	10	0.080	3.00	0.025	0.143	0.96
	30	0.074	2.91	0.112	0.130	0.60
	40	0.309	6.31	0.179	0.204	1.19
	46	0.098	7.22	0.219	0.204	2.56
47	0	0.011	5.45	0.181	0.206	1.16
	58	0.023	6.71	0.142	0.169	2.60
48	0	0.006	5.75	0.207	0.189	0.92
	57	0.017	6.69	0.110	0.178	1.55
49	0	0.090	6.49	0.191	0.144	1.28
	30	0.132	3.83	0.106	0.188	2.12
	53	0.106	5.57	0.122	0.159	1.31
50	0	0.164	7.12	0.151	0.164	0.66
	50	0.103	7.67	0.145	0.119	1.44
51	0	0.027	7.98	0.215	0.159	1.21
	10	0.016	7.24	0.147	0.193	1.11
	46	0.031	11.10	0.157	0.233	2.14
52	0	0.146	7.26	0.211	0.147	1.85
	38	0.178	7.74	0.112	0.137	0.63
53	0	0.171	5.56	0.177	0.134	1.94
	10	0.118	5.76	0.145	0.129	0.92
	51	0.144	6.26	0.123	0.136	1.34
54	0	0.135	3.59	0.218	0.135	1.43
	60	0.119	6.13	0.146	0.184	1.57
55	0	0.013	5.98	0.236	0.194	1.34
	59	0.031	6.75	0.134	0.187	2.76
56	0	0.030	5.88	0.116	0.154	0.86
	60	0.040	6.14	0.138	0.199	2.64
57	0	0.038	4.43	0.103	0.178	1.04
	30	0.041	6.56	0.152	0.212	2.78
	59	0.028	7.48	0.152	0.170	1.01
58	0	0.032	7.23	0.189	0.183	0.84
	60	0.035	8.76	0.119	0.182	2.14
59	0	0.008	6.01	0.141	0.204	0.94
	63	0.026	5.35	0.094	0.181	1.26

Appendix B. continue

Stations	Depth (m)	Pb (μg/l)	Cd (ng/l)	Cu (μg/l)	Ni (μg/l)	Fe (μg/l)
60	0	0.017	6.88	0.165	0.187	1.50
	57	0.014	7.02	0.089	0.183	0.70
61	0	0.106	11.38	0.244	0.254	3.03
	20	0.043	5.22	0.174	0.306	3.34
	48	0.022	6.79	0.094	0.161	0.93
62	0	0.076	4.85	0.163	0.134	0.11
	20	0.061	3.50	0.079	0.114	0.20
	58	0.061	4.35	0.115	0.152	0.63
63	0	0.052	3.86	0.187	0.186	0.46
	64	0.050	4.12	0.086	0.356	0.83
64	0	0.048	3.87	0.242	0.223	0.33
	57	0.051	5.53	0.084	0.154	0.24
65	0	0.044	4.08	0.168	0.150	0.22
	64	0.047	3.43	0.090	0.144	0.45
66	0	0.042	4.55	0.145	0.136	0.22
	70	0.044	3.29	0.078	0.104	0.23
67	0	0.176	4.96	0.156	0.182	0.70
	30	0.117	3.23	0.156	0.154	0.90
	76	0.066	4.05	0.076	0.127	0.53
68	0	0.016	12.33	0.182	0.215	1.11
	40	0.008	3.79	0.104	0.142	1.05
	71	0.012	5.06	0.082	0.201	0.58
69	0	0.181	8.50	0.170	0.206	1.22
	20	0.275	4.93	0.144	0.231	0.98
	25	0.149	4.35	0.125	0.198	0.93
	40	0.193	5.47	0.123	0.156	0.83
	45	0.174	4.09	0.126	0.174	1.69
	64	0.176	7.15	0.105	0.188	1.33
70	0	0.053	5.19	0.095	0.105	0.37
	15	0.050	9.13	0.079	0.106	0.41
	38	0.084	6.13	0.066	0.100	0.40
71	0	0.062	6.05	0.349	0.228	0.76
	15	0.086	8.40	0.236	0.198	0.29
	30	0.080	5.04	0.080	0.137	0.43
72	0	0.092	1.60	0.160	0.269	1.93
	20	0.092	10.20	0.101	0.194	1.57
	54	0.074		0.093	0.249	0.67
73	0	0.015	5.23	0.215	0.202	1.47
	30	0.024	3.48	0.074	0.187	1.41
	72	0.012	4.74	0.086	0.155	0.89
74	0	0.160	9.24	0.120	0.111	0.82
	25	0.124	5.33	0.051	0.094	1.02
	66	0.167	4.62	0.040	0.108	0.30
75	0	0.109	6.04	0.097	0.101	0.39
	10	0.145	3.56	0.051	0.094	0.59
	54	0.160	6.40	0.051	0.097	0.70
76	0	0.083	24.14	0.135	0.112	0.47
	10	0.115	8.52	0.115	0.123	0.59
	26	0.148	3.61	0.088	0.117	0.57
77	0	0.123	6.25	0.152	0.147	0.75
	10	0.186	3.62	0.092	0.124	1.11
	48	0.125	3.59	0.105	0.116	1.36
78	0	0.114	2.69	0.166	0.119	1.09
	28	0.164	2.83	0.291	0.129	1.82
	63	0.077	9.49	0.071	0.117	0.44
79	0	0.181	9.82	0.170	0.143	1.07
	10	0.132	8.26	0.145	0.133	0.79
	25	0.058	8.15	0.119	0.125	0.95
	30	0.067	6.63	0.113	0.115	0.66
	50	0.089	5.05	0.085	0.145	1.41
	59	0.110	5.58	0.124	0.108	0.66
80	0	0.055		0.201	0.176	1.13
	15	0.074	8.45	0.135	0.182	0.74
	31	0.079	3.63	0.170	0.198	1.72
81	0	0.123	4.86	0.178	0.209	0.98
	10	0.129	6.75	0.124	0.178	2.31
	53	0.105	5.13	0.117	0.209	1.90